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On Dirac equation for a Coulomb scalar, vector, and tensor interaction

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Abstract

In their recent paper (Inter. J. Mod. Phys. A **26** (2011) 1011), Zarrinkamar and coauthors have considered the radial Dirac equation for a Coulomb scalar, vector and tensor interaction. The exact solutions for the energy eigenvalues they have reported for spin-symmetry and pseudo-spin symmetry were mishandled and are incorrect eigenvalues, therefore.

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.In their recent paper, Zarrinkamar, Hassanabadi and Rajabi (Inter. J. Mod. Phys. A 26 (2011) 1011), have considered the radial Dirac equation for

a Coulomb scalar, vector and tensor interaction. They were successful in working out the exact solutions as inferred from the 1D-radial Schrödinger Coulomb problem as

$$E^2 - m^2 = -\frac{b^2 \left(E+m\right)^2}{4N^2} \; ; \; N = n_r + k - a + 1, \tag{1}$$

for the spin symmetric case (see their Eq.(12a)), and

$$E^2 - m^2 = -\frac{b^2 \left(E-m\right)^2}{4\,\tilde{N}^2} \; ; \; \tilde{N} = n_r + k - a, \tag{2}$$

for the pseudo-spin symmetric case (see their Eq.(17a)).

A proiri, these two equations are not quadratic in E (cf. e.g., Mustafa [1,2]) to imply two branches of eigenvalues. obviously, equation (1) yields

$$E - m = -\frac{b^2 \left(E+m\right)}{4N^2}, \tag{3}$$

and equation (2) implies

$$E + m = -\frac{b^2 \left(E-m\right)}{4\,\tilde{N}^2}. \tag{4}$$

Therefore, the energy eigenvalues should read

$$E = \frac{\left(4N^2 - b^2\right) m}{4N^2 + b^2}, \tag{5}$$

for the spin symmetric case, and

$$E = -\frac{\left(4\,\tilde{N}^2 - b^2\right) m}{4\,\tilde{N}^2 + b^2}, \tag{6}$$

for the pseudo-spin case.

As such, their results reported in their equations (12b) and (17b) are unfortunate and incorrect therefore.

References

[1] O Mustafa, Int. J. Theor. Phys. **47**, 1300 (2008)

[2] O. Mustafa, J. Phys. A; Math & Gen. **36**, 5067 (2003)